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ECOLOGICAL RELATIONSHIPS BETWEEN NESTING SWAINSON'S AND RED-TAILED HAWKS IN SOUTHEASTERN IDAHO

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ABSTRACT.—We compared reproductive success, nest site characteristics, and food habits of nesting Swainson's hawks (*Buteo swainsoni*) and red-tailed hawks (*B. jamaicensis*) along the Big Lost River and Birch Creek on the Idaho National Engineering Laboratory, southeastern Idaho, from 1991–93. Productivity was similar between species. Twenty-four red-tailed hawk nests produced 34 fledglings (1.4/attempt) while 17 Swainson's hawk nests produced 21 fledglings (1.2/attempt). Nest trees used by Swainson's hawks were shorter, smaller, and more foliated than those used by red-tailed hawks ($P < 0.01$). Swainson's hawk nest trees were more foliated than most trees along Birch Creek and the Big Lost River ($P < 0.006$). Red-tailed hawk nest trees were similar to available deciduous trees (>25% dead), but were taller ($P = 0.001$). Prey remains and castings at nests (% frequency), indicated that Swainson's hawks preyed more commonly on birds than red-tailed hawks while the latter more commonly captured *Lepus* spp. and Sciuridae; Leporidae, including *Lepus* spp. and *Sylvilagus* spp., made up over 60% of the estimated prey biomass for both species. Riparian vegetation condition, notably the lack of narrowleaf cottonwood (*Populus angustifolia*) survival and regeneration, appeared to be a major factor accounting for changes in hawk distribution on the study area.

KEY WORDS: *food habits; habitat degradation; Idaho; nesting; red-tailed hawk; Swainson's hawk.*

Relaciones ecológicas entre *Buteo swainsoni* y *Buteo jamaicensis* nidificantes en el sureste de Idaho

RESUMEN.—Entre 1991 y 1993 comparamos éxito reproductivo, características del sitio de nidificación y hábitos alimentarios de *Buteo swainsoni* y *Buteo jamaicensis* a lo largo de Big Lost River y Birch Creek en el Idaho National Engineering Laboratory, al sureste de Idaho. La productividad fue similar entre ambas especies. Veinticuatro nidos de *B. jamaicensis* produjeron 34 volantones (1.4/nido) mientras que 17 nidos de *B. swainsoni* produjeron 21 volantones (1.2/nido). Los árboles utilizados para nidificar por *B. swainsoni* fueron más cortos, más pequeños y con mayor dosel que los utilizados por *B. jamaicensis* ($P < 0.01$). Los árboles para nidificación de *B. swainsoni* poseían un dosel más denso que la mayoría de los árboles a lo largo de Birch Creek y del Big Lost River ($P < 0.006$). Lós árboles de nidificación de *B. jamaicensis* eran similares a árboles deciduos (>25% muertos) pero eran más delgados ($P = 0.001$). Los restos de presas y su distribución en el nido (% de frecuencia), indicaron que *B. swainsoni* predaba más comunmente sobre aves que *B. jamaicensis,* mientras que este último capturaba comunmente *Lepus* spp. y Sciuridae; Leporidae, incluyendo *Lepus* spp. y *Sylvilagus* spp., constituyó sobre el 60% de la biomasa de presas estimada para ambas especies. La condición de la vegetación ribereña parece ser un factor importante en el cambio de distribución de *B. swainsoni* en el área de estudio.

[Traducción de Ivan Lazo]

Availability of nesting habitat can be a limiting factor in raptor communities (Newton 1976). The availability of nesting substrate can be especially important for tree-nesting raptors in regions where trees are scarce (Schmutz 1984). Trees along riparian corridors may concentrate nesting raptors. On the Idaho National Engineering Laboratory (INEL), trees along the Big Lost River and Birch Creek serve as nesting habitat for several raptor species (Craig 1979, Hansen 1994). Swainson's hawks (*Buteo swainsoni*) have been historically the most common *Buteo* species nesting along riparian corridors on the INEL (Craig 1979). However, red-tailed hawk (*B. jamaicensis*) nesting has increased greatly on the study area since the early 1980s (Craig et al. 1984, Hansen 1994). We measured the nesting habitat, food habits, and productivity of both species to examine the re-

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lationships between nesting Swainson's hawks and an expanding red-tailed hawk population.

STUDY AREA AND METHODS

The INEL is a 230 000-ha National Environmental Research Park administered by the United States Department of Energy. It is located on the upper Snake River plain in southeastern Idaho (Fig. 1). Human access is restricted to people conducting site maintenance or field research. Most human-related influences on nesting raptors are indirect.

The climate at the INEL is typical of a cold, semi-arid desert, with temperatures ranging between −42 and 39° C, and precipitation averaging 21 cm annually (Clawson et al. 1989). Vegetation on the INEL is dominated by big sagebrush (*Artemisia tridentata*) communities (McBride et al. 1978). Narrowleaf cottonwoods (*Populus angustifolia*) and western water birch (*Betula occidentalis*) along the Big Lost River and Birch Creek, as well as scattered Utah junipers (*Juniperus osteosperma*) provide the majority of raptor nesting habitat on the INEL. Understory vegetation varies little between the river corridors and sagebrush uplands.

We searched the entire length of the Big Lost River and Birch Creek on the INEL for nesting red-tailed and Swainson's hawks from March through July in 1991, 1992, and 1993. Nest search procedures used on the remainder of the INEL are detailed elsewhere (Hansen 1994). Brief, biweekly visits to nest sites provided us with reproductive data for all nesting hawks. During nest visits, we collected prey remains and pellets to determine food habits. Prey occurrence was determined by counting mandibles and by characteristic body parts such as feathers or scales (Marti 1987). Following fledging or nesting failure, we measured nest-site characteristics. These characteristics included: outside nest diameter, nest and nest substrate heights, diameter at breast height (dbh) of nest trees, condition of the nest tree (based on 25% increments of foliation), and predominant vegetation community at the nest site. Available nesting habitat was determined by measuring height and condition of all the trees along Birch Creek and those within 10 random 2-km stretches of the Big Lost River (hereafter referred to as available trees). Reference to nests refers to active hawk nests unless indicated otherwise.

We used Wilcoxon 2-way comparisons to determine interspecific differences in nest site characteristics ($\alpha \leq 0.05$). Food habits were compared using Shannon's (Shannon and Weaver 1949) and Pielou's (1969) diversity indices, as well as Pianka's (1973) overlap index. Estimates of prey biomass were obtained from Steenhof (1983).

RESULTS AND DISCUSSION

We noted considerably more red-tailed hawk nesting during our study than was reported for the INEL in 1974–76, when only one active nest was located (Craig 1979). Four active red-tailed hawk nests were noted on the entire INEL in 1982 and 1987 (Craig et al. 1984, J. Kirkley unpubl. data), and we found 8, 13, and 12 nests from 1991–93 on the entire INEL

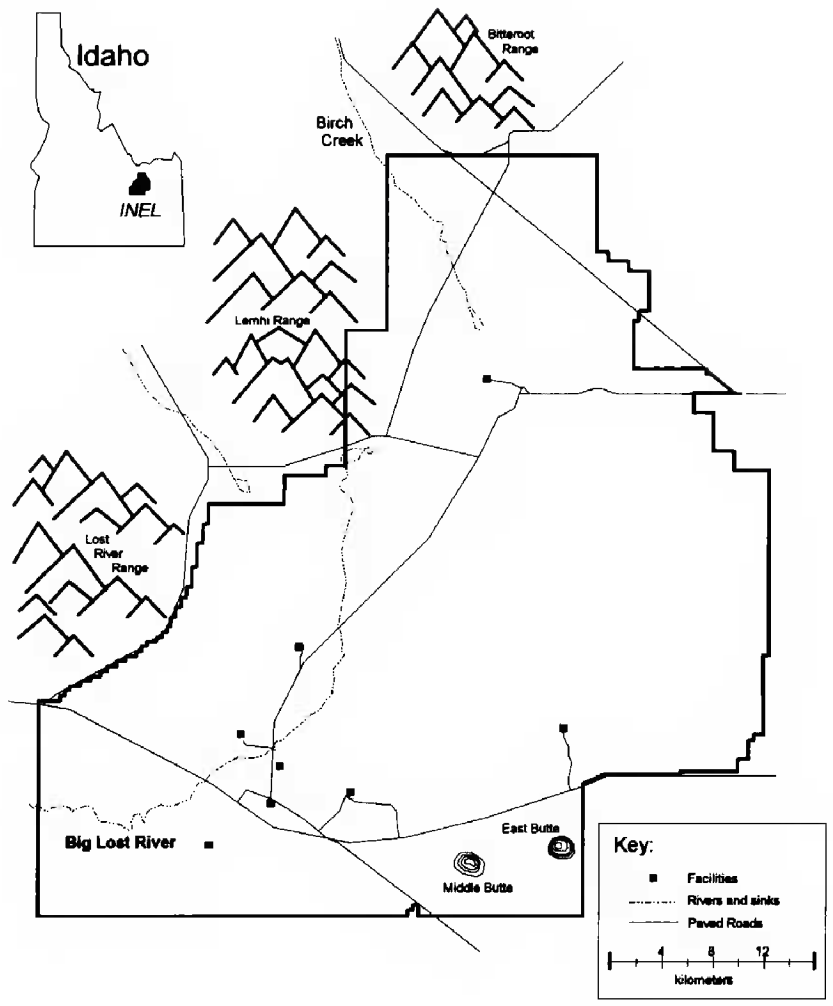

Figure 1. The Idaho National Engineering Laboratory showing relative locations of the Big Lost River, Birch Creek, and site facilities.

(Hansen 1994). All but nine of the red-tailed hawk nests we found were in deciduous trees along the Big Lost River; no nests were found on Birch Creek. Platt (1971) and Thurow et al. (1980) also found that red-tailed hawks in desert regions of northern Utah and southern Idaho selected deciduous trees for nesting.

The Swainson's hawk nesting populations on the INEL appear to have increased from the mid-1970s through our study. Craig (1979) found 12 active Swainson's hawk nests on the INEL over a 3-yr period from 1974–76, mostly along the Big Lost River. All nests located by Craig on the INEL in the 1970s were in deciduous trees along water courses or near agricultural areas. Seven active Swainson's hawk nests were located on the INEL in 1982 (Craig et al. 1984). We found 8, 10, and 10 active Swainson's hawk nests on the entire INEL for the years from 1991–93. Seventeen of 28 Swainson's hawk nests in our study were along the Big Lost River and Birch Creek, 16 of which were in deciduous trees; nine of the 17 nests were located on Birch

Table 1. Productivity of red-tailed and Swainson's hawks nesting along the Big Lost River and Birch Creek on the Idaho National Engineering Laboratory, 1991–93.

		Number of Occupied Nests	Number of Nestlings[a]	Number of Fledglings	Number of Successful Nests[b]	Fledglings per Successful Nest	Fledglings per Nest
Red-tailed hawk	1991	7	13	13	7	1.9	1.9
	1992	9	22	15	7	2.1	1.7
	1993	8	19	6	3	2.0	0.8
Swainson's hawk	1991	4	8	7	4	1.8	1.8
	1992	6	13	8	5	1.6	1.3
	1993	7	14	6	4	1.5	0.9

[a] Minimum number.
[b] Nests that fledged at least one nestling.

Creek. The remainder of the Swainson's hawk nests were in junipers scattered around the INEL (Hansen 1994). Earlier nest surveys were conducted with methods similar to ours (Craig 1979, Craig et al. 1984); i.e., most of the INEL was searched and potential habitat and nest sites were investigated.

Red-tailed hawk productivity was similar to Swainson's hawk productivity on a per nest basis for the combined Big Lost River and Birch Creek areas during our study (Table 1). High nest failure occurred in red-tailed hawks in 1993, primarily due to structural failure of nests or nestling exposure to unusually cold, wet weather. Swainson's hawks along the Big Lost River and Birch Creek also had high failure rates, but the three nests found in junipers elsewhere on the INEL all fledged young (Hansen 1994). Red-tailed hawks tended to produce more fledglings per successful nest than Swainson's hawks in 1992 and 1993. Swainson's hawk productivity was highly variable by year in our study but fell within the range reported in the literature (Craighead and Craighead 1956, Platt 1971, Craig 1979, Fitzner et al. 1981, Gilmer and Stewart 1984). Red-tailed hawk production per nesting attempt on the Big Lost River (no nesting on Birch Creek) was similar to that noted in other studies (Johnson 1975, Wiley 1975, Fitzner et al. 1981). We could not compare clutch sizes because we waited until after incubation to begin nest visits in order to minimize nest desertion.

Red-tailed hawks nested in taller trees than Swainson's hawks ($Z = 3.28$, $P = 0.001$; Fig. 2); red-tailed hawk nest trees were also taller than trees occurring randomly along the Big Lost River ($Z = 2.76$, $P = 0.006$). Correspondingly, red-tailed hawk nest trees had the larger dbh (median = 44 cm, quartiles = 42–52 cm) than Swainson's hawk nest trees (median = 29 cm, quartiles = 15–36 cm; $Z = 5.49$, $P = 0.001$). The affinity of red-tailed hawks for tall nesting substrates has been reported by several investigators (Schmutz et al. 1980, Thurow et al. 1980, Bechard et al. 1990, Restani 1991). Both species tended to nest in trees that were taller than the average height of trees in the surrounding stands ($Z = 5.17$, $P = 0.001$; Fig. 2), but they did not necessarily nest in the tallest tree in that stand.

Swainson's hawk nests were smaller in diameter (median = 53 cm, quartiles = 43–59 cm) than red-tailed hawk nests (median = 57 cm, quartiles = 55–72 cm), but the difference was not significant ($Z = 1.19$, $P = 0.23$). Both species occasionally used old ferruginous hawk (*Buteo regalis*) nests, but most nests along the Big Lost River and Birch Creek were constructed by the hawks nesting in them. Swainson's hawk nests rarely survived more than a year due to their flimsy nature, so they were not reused. The flimsy nature of Swainson's hawk nests was noted elsewhere (Call 1978).

Swainson's hawks nested in trees with more foliage (median = 75%, quartiles = 25–100%) than did red-tailed hawks (median = 0%, quartiles = 0–25%); they also nested in trees with more foliage than the trees occurring randomly along the Big Lost River and Birch Creek (median = 0%, quartiles = 0–25%; $Z = 2.27$, $P = 0.001$). Concealment or shading of nests may have been reasons for Swainson's hawk selection of well-foliated trees. Thermoregulation has been cited as a factor possibly affecting

the nest placement of other raptor species (Bednarz and Dinsmore 1982, Viñuela and Sunyer 1992). Other studies also found that Swainson's hawks' nests were similarly concealed in foliage (Dunkle 1977, Thurow and White 1983), but the relationship between nest site selection and tree condition (foliation) is not well-documented.

Degradation of deciduous trees along the Big Lost River and Birch Creek may be a factor influencing Swainson's hawk nesting in these areas. Swainson's hawks clearly displayed an affinity for well-foliated trees during our study, but such trees are becoming increasingly rare along the riparian corridors of the INEL. In the 1970s and early 1980s, the Big Lost River flowed on the INEL at least part of every year (Bennett 1990). Between 1987 and 1992 no water flowed on the study area due to a prolonged drought and diversion for irrigation west of the INEL. As a result, riparian vegetation along the channel degraded considerably. All the willow (*Salix* spp.) stands along the river were dead during our study. Cottonwood growth was curtailed, and by 1991 many mature trees were dead or dying; regeneration was almost nonexistent. Only three living cottonwoods <20 cm dbh were noted during our surveys of available nest trees along 20 km of the Big Lost River (Hansen 1994). Trees along Birch Creek were in better condition; 21 small trees were living along the 8 km we surveyed, but most of the trees along this channel were also seriously degraded. The only saplings we noted were associated with the roots of large trees (>45 cm dbh).

The degradation of Swainson's hawk nesting habitat along the Big Lost River may have benefitted red-tailed hawks by reducing direct interaction between the species and potentially increasing productivity. Interspecific interactions between red-tailed and Swainson's hawks can result in loss of some territory to the later nesting Swainson's hawk (Janes 1994). While territory loss to Swainson's hawks may not have a direct effect on red-tailed hawk nesting success (Janes 1984), factors affecting prey delivery may be deleterious to successful reproduction (Stinson 1980, Cress and Langley 1988).

No significant differences were found between red-tailed and Swainson's hawks in distances to human activity or in vegetation communities surrounding the nest site (sagebrush dominated grassland) on the Big Lost River. This may have been a result of the concentration of human activity along the Big Lost River (Fig. 1), and relatively monotypic vegetational

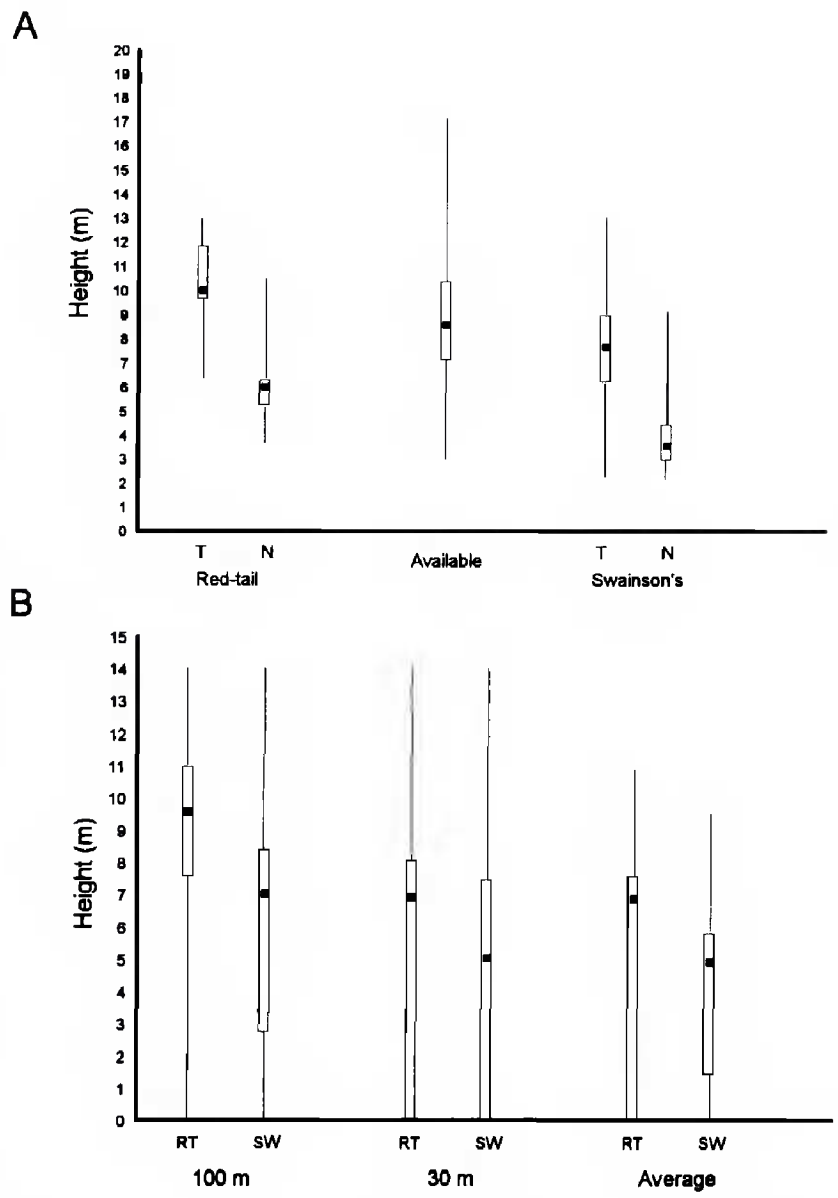

Figure 2. Box plots (median ± quartiles, range) of tree heights along the Big Lost River and Birch Creek on the Idaho National Engineering Laboratory: (A) nest (N) and nest tree (T) heights of red-tailed hawk and Swainson's hawk nest sites, and height of available trees; (B) tallest tree within 30 and 100 m of hawk nests and average height of trees within 30 m of nest tree.

communities along this corridor (McBride et al. 1978).

Continued degradation of vegetation along the Big Lost River and Birch Creek will probably result in decreased Swainson's hawk nesting along these channels. Tree condition appears to be a major factor influencing their nesting along these channels, and reduction of narrowleaf cottonwoods and western water birch (on Birch Creek) may reduce the suitability of this area for Swainson's hawk nesting. Without regular stream flow, the lack of deciduous tree regeneration and collapse of dead trees will eventually make these watercourses unsuitable for all tree-nesting raptors. As a result, a greater proportion of red-tailed and Swainson's hawks will have

Table 2. Prey of nesting red-tailed (19 nests, 55 items) and Swainson's hawks (11 nests, 35 items) along the Big Lost River and Birch Creek on the Idaho National Engineering Laboratory, 1991–93, determined from prey remains and castings (expressed as percent frequency of occurrence and percent of total ingested biomass).

	Red-tailed Hawk		Swainson's Hawk	
Prey Category	% Freq.	% Biomass	% Freq.	% Biomass
Microtus spp.	21.9	2.3	11.4	2.3
Neotoma spp.	3.6	3.0	2.9	4.5
Other Cricetidae	10.9	0.4	22.9	1.7
Thomomys spp.	9.1	5.9	11.4	14.1
Sciuridae	9.1	2.8	2.9	1.7
Sylvilagus spp.	21.9	28.2	17.1	42.3
Lepus spp.	12.7	50.5	2.9	21.7
Aves	3.6	4.2	25.7	11.4
Reptilia	7.2	2.7	2.9	0.3
Diversity				
Shannon's Index[a]	0.99	0.62	1.07	0.72
Pielou's Index[b]	0.86	0.54	0.89	0.59

[a] Shannon and Weaver (1949).
[b] Pielou (1969).

to nest in junipers or move away from the INEL. During this study, 24 of 33 (73%) red-tailed hawk nests on the INEL were in cottonwoods along the Big Lost River and 16 of 28 (57%) Swainson's hawk nests on the INEL were in cottonwoods or birches along the river and Birch Creek (Hansen 1994).

Based on frequency of prey occurrence, both species had fairly broad diets (Table 2). Dietary overlap was high between these species using both frequency (0.83) and biomass (0.95) measures. Lagomorphs accounted for over 50% of the estimated biomass of prey items and accounted for much of the dietary overlap. However, red-tailed hawks tended to feed on *Lepus* and *Sylvilagus* spp. while Swainson's hawks took primarily *Sylvilagus* spp. Red-tailed hawks preyed more commonly on Sciuridae and reptiles than did Swainson's hawks. Swainson's hawks commonly preyed on birds as observed by Craig (1979) although, differing from our results, Craig did not find *Thomomys* spp. in the diets of Swainson's hawks. In contrast to our results, Schmutz et al. in Alberta recorded a higher frequency and biomass of birds in the diet of red-tailed hawks than in Swainson's hawks. Invertebrates were common in Swainson's hawk pellets, but we were unable to quantify their occurrence.

Birds and invertebrates were underrepresented using our method of food habits analysis, potentially inflating our measure of dietary overlap (Simmons et al. 1991). Additionally, our sample sizes were small, so caution should be exercised when interpreting these data. However, some generalizations can be made. Lagomorphs were an important prey item for both species. Lagomorphs, especially black-tailed jackrabbits (*Lepus californicus*), are an important prey resource for *Buteo*s throughout this region (Platt 1971, Craig 1979, Thurow et al. 1980, Smith et al. 1981). Black-tailed jackrabbit populations fluctuate greatly on the study area (French et al. 1965, Johnson and Anderson 1984). Black-tailed jackrabbit densities were low during our study and during the mid-1970s (Craig 1979). Craig et al. (1984) reported an increase in nesting Swainson's and red-tailed hawks during 1982, a year of high densities of black-tailed jackrabbits. However, numbers of nesting Swainson's hawks and red-tailed hawks in our study, a period of low black-tailed jackrabbit numbers, were even higher than in 1982 (Craig et al. 1984). Additional monitoring of this raptor community during a period of black-tailed jackrabbit abundance would provide insight into the effects of this prey on the ecological relationships between nesting Swainson's and red-tailed hawks.

We suspect that nesting red-tailed and Swainson's hawks were primarily concentrated near riparian areas because of the location of nesting trees. However, habitat along the Big Lost River, Birch Creek, and riparian areas in general, may also provide an increased diversity of prey species for nesting hawks. Unfortunately, our sample sizes are not adequate for comparing diets of upland nesting raptors versus those nesting on Big Lost River or Birch Creek. The situation along the Big Lost River underscores the fact that indirect human disturbance can affect the viability of raptor assemblages as much as direct habitat destruction. Provisions for allowing minimal but periodic flow of water to ensure adequate regeneration of narrowleaf cottonwood along the Big Lost River and Birch Creek would be particularly valuable to red-tailed and Swainson's hawks.

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